

Client's ref. : VIT02-0045  
Our ref: 0608-7907us /Karen

**What is claimed is:**

1        1.    An adaptive multi-modulus equalization method for  
2    an equalizer, comprising the steps of:  
3        storing an input signal;  
4        generating initial values for a plurality of equalizer  
5        coefficients;  
6        calculating a constant modulus algorithm (CMA) cost  
7        function output according to a CMA with an  
8        equalized signal from the equalizer;  
9        estimating a CMA adjustment amount for updating the  
10       equalizer coefficients according to the CMA cost  
11       function output;  
12       determining modulus of each region for a multi-modulus  
13       algorithm (MMA) by statistical analysis of the  
14       equalized signal;  
15       switching the equalizer to use the MMA when the CMA  
16       cost function output reaches a first threshold,  
17       wherein the MMA comprises a plurality of stages  
18       determined by thresholds, and the number of  
19       regions increases in each subsequent stage;  
20       calculating a MMA cost function output according to the  
21       MMA with the equalized signal and modulus of each  
22       region;  
23       estimating a MMA adjustment amount for updating the  
24       equalizer coefficients according to the MMA cost  
25       function output;

26 determining modulus of each region for the subsequent  
27 stage of the MMA by statistical analysis of the  
28 equalized signal;  
29 switching the equalizer to the subsequent stage of the  
30 MMA when the MMA cost function output reaches the  
31 threshold corresponding to the current stage;  
32 repeating the steps of calculating the MMA cost  
33 function output, determining modulus of each  
34 region, and switching the equalizer to the  
35 subsequent stage until the MMA cost function  
36 output reaching a preset value; and  
37 fixing the number of regions and equalizer coefficients  
38 to equalize the input signal when the MMA cost  
39 function output has reached the preset value.

1 2. The method as claimed in claim 1 further  
2 comprising the steps of:  
3 phase recovering and non-linear transforming the  
4 equalized signal into a recovered signal; and  
5 inputting the recovered signal to a decision feedback  
6 equalizer.

1 3. The method as claimed in claim 1 wherein the CMA  
2 cost function output and the MMA cost function output are  
3 calculated by two second-order discrete cost functions.

1 4. The method as claimed in claim 1 wherein the  
2 constant modulus algorithm (CMA) is implemented by a  
3 steepest gradient descent algorithm.

1        5. The method as claimed in claim 1 wherein the  
2 multi-modulus algorithm (MMA) is implemented by a steepest  
3 gradient descent algorithm.

1        6. An adaptive multi-modulus equalizing system,  
2 comprising:  
3        an equalizer, generating an equalized signal from an  
4        input signal according to equalizer coefficients;  
5        a first coefficient generator, estimating a first  
6        adjustment amount by calculating a first cost  
7        function output according to a constant modulus  
8        algorithm (CMA);  
9        a second coefficient generator, estimating a second  
10       adjustment amount by calculating a second cost  
11       function output according to a multi-modulus  
12       algorithm (MMA); and  
13       a multiplexer connected to the equalizer, selecting  
14       either the first adjustment amount or the second  
15       adjustment amount with which to update the  
16       equalizer coefficients depending on a first  
17       threshold;

1       7. The system as claimed in claim 6, wherein the  
2 first coefficient generator calculates the first cost  
3 function output from the input signal and the equalized  
4 signal.

1       8. The system as claimed in claim 6, wherein the  
2 second coefficient generator calculates the second cost  
3 function output from the input signal, the equalized signal,

4 and moduli obtained by statistical analysis of the equalized  
5 signal.

1 9. The system as claimed in claim 8, wherein the  
2 number of moduli used to calculate the second cost function  
3 output is incremental when the second cost function output  
4 reached a second threshold.

1 10. An adaptive multi-modulus equalization method for  
2 an equalizer, comprising the steps of:  
3 storing an input signal;  
4 generating initial values for a plurality of equalizer  
5 coefficients;  
6 calculating a constant modulus algorithm (CMA) cost  
7 function output according to a CMA with an  
8 equalized signal from the equalizer;  
9 estimating a CMA adjustment amount for updating the  
10 equalizer coefficients according to the CMA cost  
11 function output; and  
12 determining modulus of each region for a multi-modulus  
13 algorithm (MMA) by statistical analysis of the  
14 equalized signal.

1 11. The method as claimed in claim 10 further  
2 comprising the step of switching the equalizer to use the  
3 MMA when the CMA cost function output reaches a first  
4 threshold, wherein the MMA comprises a plurality of stages  
5 determined by thresholds, and the number of regions  
6 increases in each subsequent stage.

1        12. The method as claimed in claim 11 further  
2 comprising the steps of:  
3        calculating a MMA cost function output according to the  
4        MMA with the equalized signal and modulus of each  
5        region;  
6        estimating a MMA adjustment amount for updating the  
7        equalizer coefficients according to the MMA cost  
8        function output; and  
9        determining modulus of each region for the subsequent  
10       stage of the MMA by statistical analysis of the  
11       equalized signal.

1        13. The method as claimed in claim 12 further  
2 comprising the step of switching the equalizer to the  
3 subsequent stage of the MMA when the MMA cost function  
4 output reaches the threshold corresponding to the current  
5 stage.

1        14. The method as claimed in claim 13 further  
2 comprising the steps of:  
3        repeating the steps of calculating the MMA cost  
4        function output, determining modulus of each  
5        region, and switching the equalizer to the  
6        subsequent stage until the MMA cost function  
7        output reaches a preset value; and  
8        fixing the number of regions and the equalizer  
9        coefficients to equalize the input signal when  
10       the MMA cost function output has reached the  
11       preset value.

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1        15. The method as claimed in claim 14 further  
2 comprising the steps of:  
3        phase recovering and non-linear transforming the  
4        equalized signal into a recovered signal; and  
5        inputting the recovered signal to a decision feedback  
6        equalizer.

1        16. The method as claimed in claim 15 wherein the CMA  
2 cost function output and the MMA cost function output are  
3 two second-order discrete cost functions.

1        17. The method as claimed in claim 10 wherein the CMA  
2 is implemented by a steepest gradient descent algorithm.

1        18. The method as claimed in claim 10 wherein the MMA  
2 is implemented by a steepest decent algorithm.